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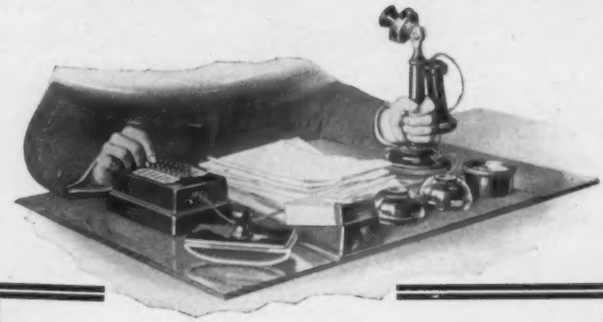

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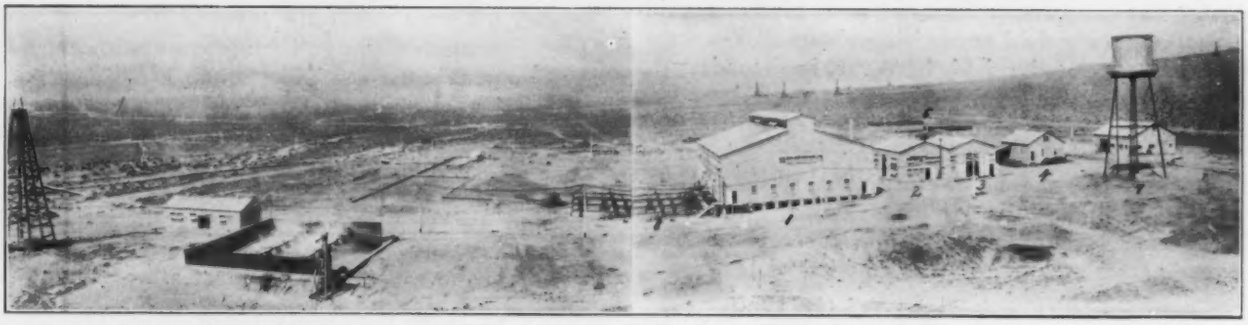


General View of Taft Compressor Station. (1) Main Gas Compressor Plant, (2) Electric and Air Compressor Plant, (3) Machine Shop, (4) Storage House, (5) Garage, (6) Employes' Homes, (7) Water Storage Tank, (8) Gas Pipes Leading from Compressor Plant to Cooling Pond, (9) Water Cooling System.

MIDWAY NATURAL GAS TRANSMISSION LINE

(Description is here given of the wells, gathering lines, compression station, pipe line and distribution system whereby Los Angeles is supplied with natural gas from the Midway and Fullerton oil fields, distant 111 and 25 miles respectively. The gathering lines and compressor station are described in this installment and the pipe lines and terminal will be described next week.—The Editor.)

Natural gas in California seems to have been first utilized for commercial purposes at Stockton about 1890. The Stockton wells are still producing. Natural gas was discovered in the San Joaquin oil fields about 1905. The first Standard Oil gas well drilled in the Buena Vista Hills field in Kern county was completed October 11, 1909. The first gas well of the Honolulu Consolidated Oil Company, in the same field, came in on April 30, 1910. Until 1911, such gas as was utilized in the Buena Vista Hills field, was used solely for consumption in the oil fields. On April 19, 1911, the California Natural Gas Co. entered into a contract with the San Joaquin Light & Power Corporation providing for the delivery to the latter company of natural gas for the supply of Bakersfield and vicinity. In this territory, natural gas has entirely supplanted artificial gas.

In 1910, John Martin and associates became interested in natural gas in the Buena Vista Hills field. They conceived the idea of building a transmission main some 111.1 miles to Los Angeles and developing sufficient gas in the oil fields to supply the needs of Los Angeles county. On November 2, 1911, John Martin entered into a contract with the Honolulu Consolidated Oil Company for the supply by the company of natural gas in a minimum amount of 15,000,000 cu. ft. per day during the first year after the completion of the transmission main to Los Angeles county and for larger amounts during subsequent years.

On November 18, 1911, the Midway Gas Company was incorporated for the purpose of constructing the necessary transmission main or mains. On December 5, 1911, before the construction of the transmission main was started, the Midway Gas Company leased such main, when completed, to the Southern California Gas Company for a period of twenty years. The Midway Gas Company thereafter built a transmission main from its Taft terminal in the Buena Vista Hills field to West Glendale, near Los Angeles, at a cost of approximately $1,500,000.

Construction on the pipe line was started in March or April, 1912, and was completed in September, 1912. Service through the pipe line started on April 28, 1913.

A few months ago, through an order of the railroad commission, the Midway Gas Company was authorized to purchase the compressor plant and gathering lines of the Southern California Gas Company and to take over all its rights and obligations in the contracts between the Midway Company and the Honolulu Consolidated Oil Company, the Southern Pacific Land Company, Kern County Trading & Oil Company and Associated Oil Company and to buy the property of the Northern Exploration Company. The contracts specify from which producing companies the gas is to be purchased, amounting to a total output of 20,000,000 cu, ft. per day. The average daily quantity of gas furnished from the Glendale Terminal of the system for use in Los Angeles, in conjunction with

artificial gas, at present, is over ten million cu. ft. during the summer months. Should the distributing companies be called upon to furnish straight natural gas this coming winter, it is estimated that about thirty million cu. ft. will be required, ten million of which being obtained from the wells in the Fullerton field. The property which the Midway Gas Company will acquire consists of the compressor plant, gathering lines, wells, etc., amounting to nearly one million dollars.

Extent of Field and Period of Available Supply.

The Midway Gas Company obtains its supply from the Buena Vista Hills in Kern county, near the town of Taft and about 40 miles west of Bakersfield, the gas producing field comprising about 18,000 acres.

The extent of the field, however, is secondary to the time during which the companies may draw gas from the field. The men who conceived the project believed the period of available supply will be from ten to fifteen years. The California Railroad Commission concluded that the Midway Company may reasonably expect to draw on this field for the service of Los Angeles and vicinity for a period of 18.6 years.

Low Pressure and High Pressure Wells.

The Midway field produces both oil and gas. Those wells producing dry gas only and no oil, under pressures exceeding 200 lb. per sq. in., are termed high pressure gas wells. Those wells producing oil and some gas, usually under pressures exceeding 100 lb. per sq. in., are termed oil wells producing casing-head gas.

In operating the latter, the oil is more important than the gas production. When casing-head gas is available, the wells flow under pressures ranging from 100 to 700 lb. The oil and gas are made to flow through a restricted orifice, called a flow nipple or "bean," which regulates the quantity of oil drawn from the well. When the pressure on the outlet side becomes the same as that on the inlet or well side, the production ceases. For this reason, the gas pressure available for casing-head gas seldom exceeds 100 lb. at the well, when the well pressure exceeds 100 lb. When, however, the well pressure declines to a point below the required pressure of the gathering system. the gas from the well is no longer available unless its pressure be increased by a gas compressor at the entrance to the gathering line system.

Typical Casing-Head Well Gas Trap.

The casing-head gas is obtained from oil wells by a gas trap which separates the oil and gas, causing the oil to flow into the tanks and allowing the gas to flow under pressure into the field gas collecting or gathering system.

In the case of the high pressure dry gas wells, the well pressure generally exceeds 200 lb. The required pressure on the gathering system for the Midway Company must not be less than 175 lb. per sq. in. In operation, the high pressure wells are never opened wide into the gathering system, but the flow from each well is regulated by means of a valve at the well, at such a rate as will best suit the condition of the well and the requirement of the gathering system. This is generally about 20 per cent of the open flow capacity of the well flowing against atmospheric pressure.

Consequently two distinct gathering and collecting systems are needed. The high pressure system requires a pressure of 175 lb. in the field, and delivers gas to the compressor station at about 150 lb. The average distance from the field to the station is about 8 miles. The low pressure, or casing-head system, is limited to about 100 lb. pressure in the field owing to the operating conditions at the well. This system delivers gas to the compressor station at the maximum pressure of 50 lb.

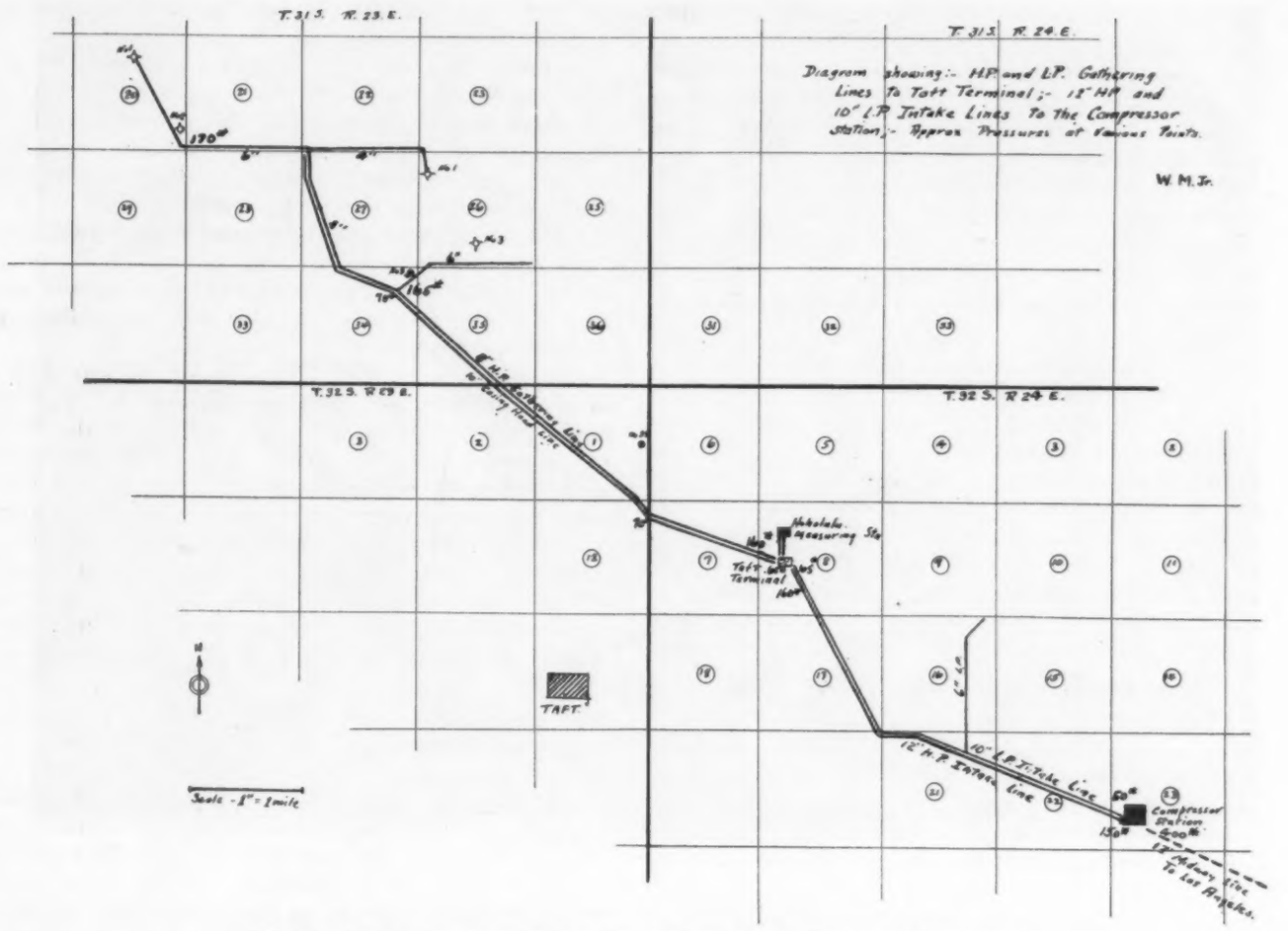
A successful gas well has been found to cost somewhat in excess of $50,000.

Gathering Lines and Taft Terminal.

The gas from the various wells, after being measured, separately, by means of field orifice meters, is all transmitted to a common point where it is measured collectively and delivered into the main lines that take it to the compressor station, this common point being the Taft terminal of the Midway line. At this point also there is delivered by another company a supply of high pressure gas under not less than 175 lb. and a supply of low pressure or casing-head gas at not less than 65 lb.

The layout at Taft terminal comprises two 8 in. field trunk lines, one for high pressure and one for low pressure gas, also one 8 in. field trunk line from the high pressure systems and a 10 in. line from the casing-head or low pressure gathering system. These four inlet lines deliver their respective gas through four orifice meters and thence all low pressure gas is delivered into a 10 in. main line, and all high pressure gas is delivered into a 12 in. main line, both running 4 miles to the compressor station, being the suction or inlet lines to this station.

At the compressor station the low pressure casing-head gas is raised from 50 to 350 or 400 lb., and the high pressure gas from 150 to 350 or 400 lb., depending upon the requirements at the point of consumption.


T. 31 S. R. 23 E.
T. 31 S. R. 24 E.
Diagram showing:- H.P. and L.P. Gathering Lines to Taft Terminal;- 12" H.P. and 10" L.P. Intake Lines to the Compressor Station;- Approx. Pressures at Various Points.
W. M. Jr.
T. 32 S. R. 23 E.
T. 32 S. R. 24 E.
Hobsclaw Measuring Sta.
Taft Terminal
TAFT
Scale - 1" = 1 mile
Compressor Station
To Los Angeles

Sketch of High Pressure and Low Pressure Gathering Lines to Taft Terminal.

Compressor Station at Taft.

Situated five miles from the nearest town and forty miles from a city of any magnitude, the layout of the group of buildings comprising the compressor station of the Midway Gas Company, clearly demonstrates the realization of this handicap by the designers of the original plant, J. G. White & Company. It includes the compressor plant with its pump house and cooling pond, an electric and air compressor station, a well equipped machine shop and garage, a warehouse, water tank, six five-room dwellings for the married men and their families, a ten-room bunk house for the single men, the chief engineer's office and a cook-house, operated for the employes.

The main building of the group is the compressor plant proper, which is steel frame throughout with galvanized corrugated steel sides and roof, the outside dimensions being 80 by 135 ft. The plant as a whole is admirably designed and shows on every hand a thoroughness and attention to detail, that can only come as a result of long experience. Plants of such a high type of construction are unusual in the oil fields and this plant is an indication of the belief of the capitalists in the stability of the industry.

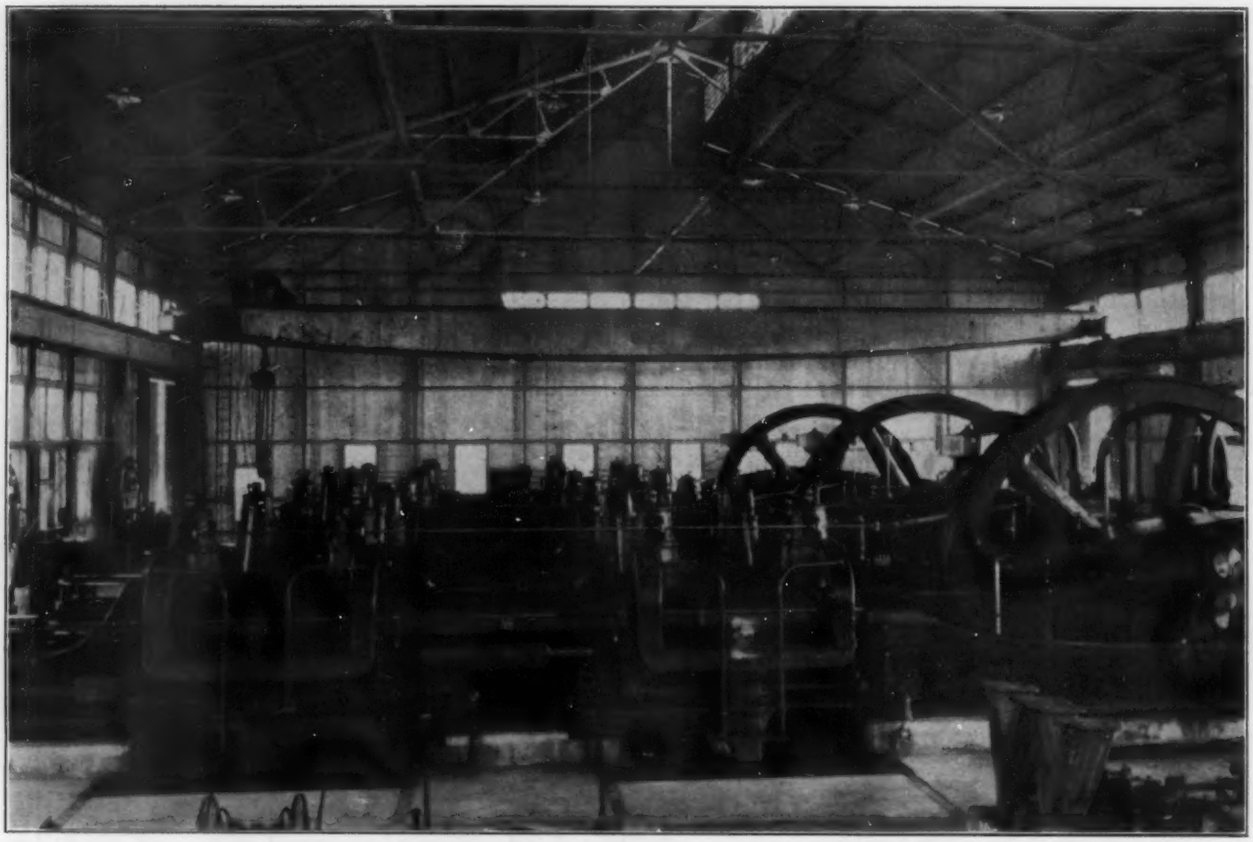
The equipment of the compressor plant consists of three main gas compressor units, each being made up of one horizontal, twin-tandem double acting gas engine, direct connected to two double acting natural gas compressors.

Each gas engine operates on natural gas as fuel, and is capable of developing 1,000 b.h.p. The dimensions of each engine are as follows:

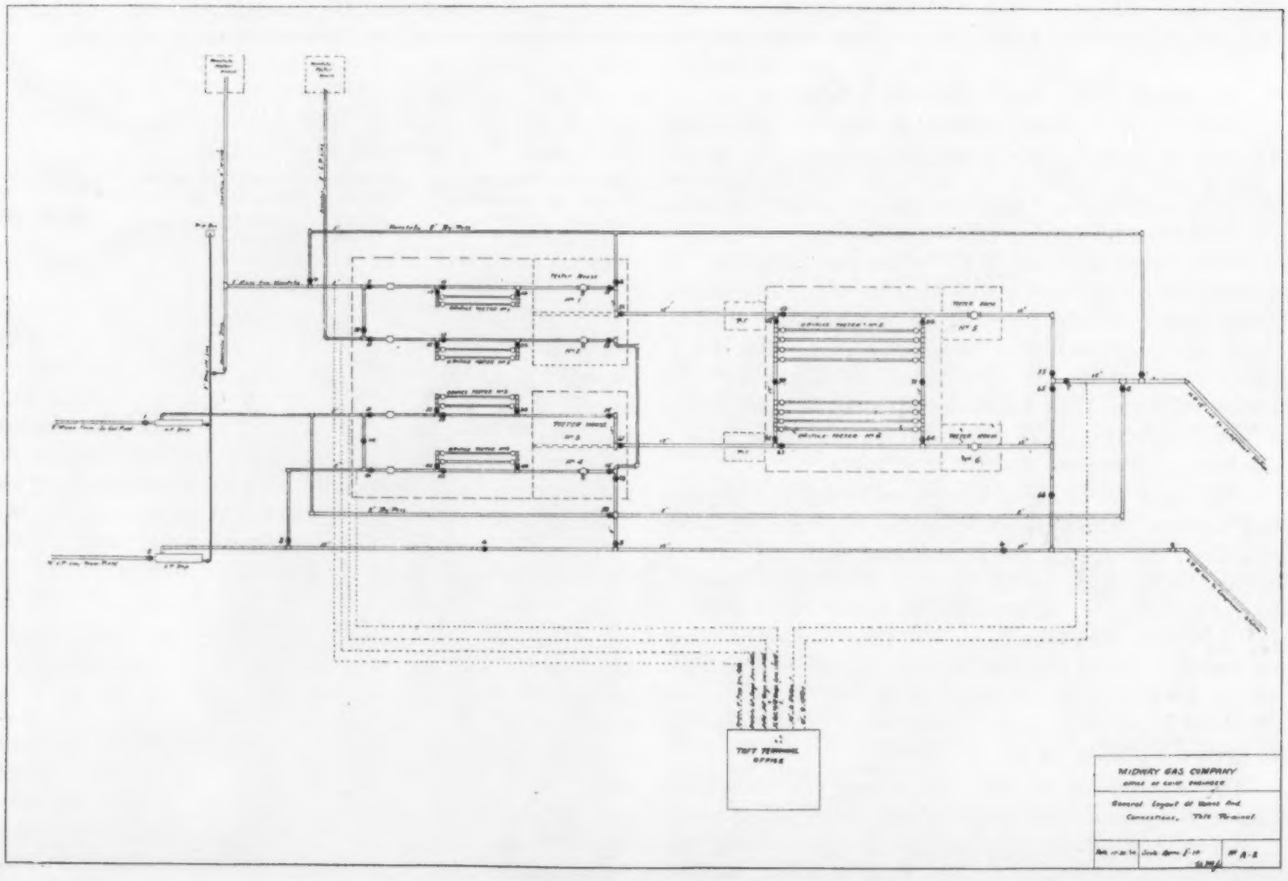
No. of cylinders...	4 each	Weight of flywheel	29,000 lb.
Diam. of cylinders	21½ in.	Weight of entire engine	297,000 lb.
Length of stroke..	42 in.		
Rev. per min.....	105	Weight of heaviest part	28,000 lb.
Diam. of piston rod.	6¼ in.		
Diam. of flywheel..	16 ft.	Floor space...	28 ft. x 62 in. ea.

Two of the gas engines are connected to four compressor cylinders capable of compressing from 150 lb. inlet to 450 lb. discharge. The cylinder dimensions are 12½ in. diameter and 42 in. stroke. These are termed the high pressure units. The other gas engine is connected to two compressor cylinders capable of compressing from 50 lb. inlet to 150 lb. discharge. The cylinder dimensions are 19⅜ in. diameter and 42 in. stroke. This is termed the low pressure unit. The capacity of each unit with normal inlet pressure is approximately 15,000,000 cu. ft. free gas per 24 hours.

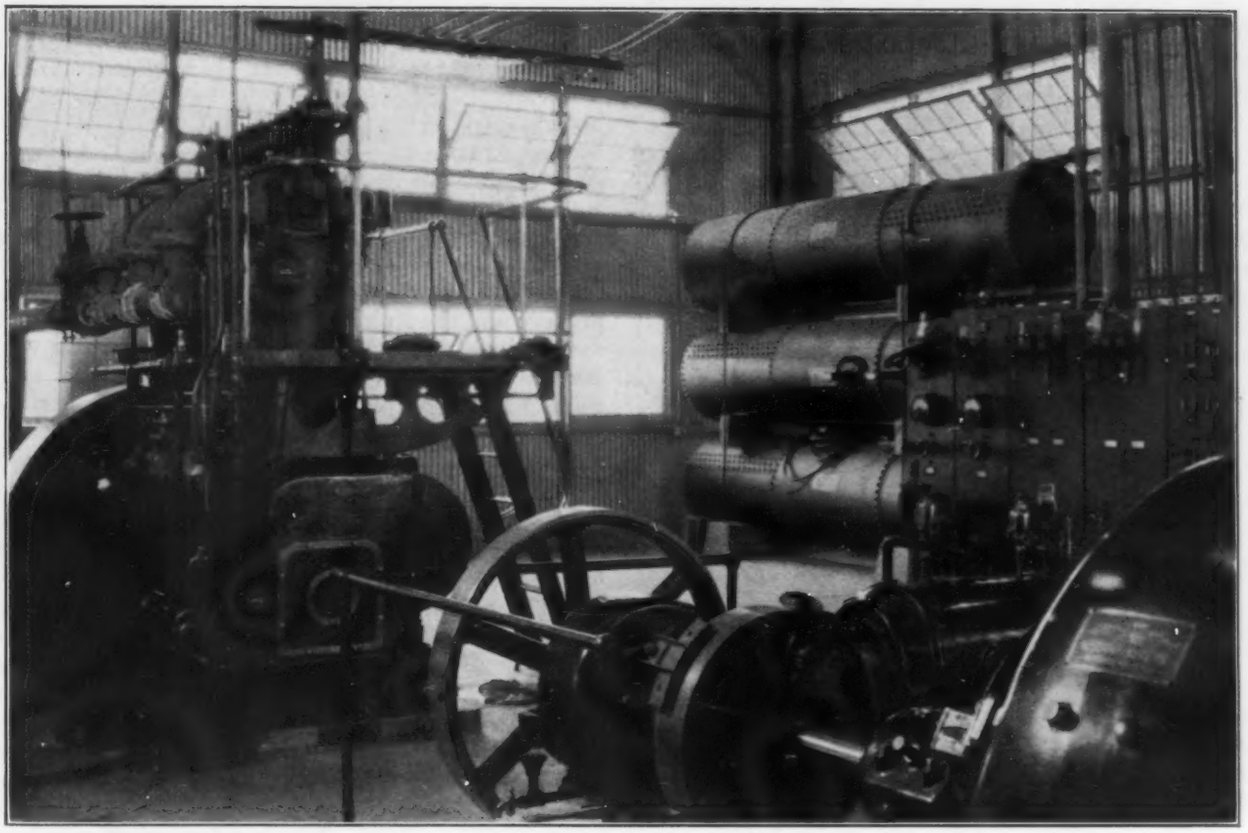
In regular operation, the low pressure or casing-head gas comes to the low pressure unit through the 10 in. low pressure intake line, and its pressure is raised from about 50 to 150 lb. From this low pressure unit it passes through the cooler and a suitable separator to remove any condensed liquid and enters one of the high pressure units where the pressure is raised from 150 lb. to the required discharge pressure into the Midway main 12 in. line, being between 350 and 400 lb. It can thus be seen that there are



Interior of Taft Compressor Plant.



Layout of Taft Terminal.



Gas Engine Driving Generator and Air Compressor for Starting Main Engines, showing "Starting Air" Tank.

required two 1000 horse power units to compress 15,000,000 ft. per day, from 50 lb. inlet to 350 or 400 lb. discharge pressure.

The third high pressure unit raises the high pressure gas which comes through the 12 in. high pressure intake line, from 150 lb., more or less, to the required discharge pressure of from 350 to 400 lb.

The lubrication for each engine is accomplished by means of multiple oil pumps. Oil from the bearings, slides and other parts drains to a settling tank. One end of an oil pump, direct driven from the engine crank shaft, delivers the oil from the settling tank to the oil filter on the engine room floor. The other end of the pump takes the clean oil from the filter and returns it to the engine. An overflow stand is provided on each engine. All excess oil at light feed is returned to the clean oil chamber in the filter.

The engines all have a centralized control from a floor stand placed just back of the engines and midway between the two sides. Valves on the floor stand control the compressed air inlets, gas inlet, spark oil and cooling water. An engine can be started from a state of rest and get up to full speed within about a minute.

The method of starting the main engines is strikingly similar to that employed on Diesel engines. There are two electric generating sets, one of which is a stand-by. Each generating set comprises a 3-cylinder vertical natural gas engine with cylinders 15 by 15, 175 b.h.p. at 257 r.p.m. To each engine is direct connected a direct current generator, 125 volt, 880 amperes. Each engine is also arranged to drive direct, by means of a friction clutch coupling, a tandem two-stage compressor 10¼ in. L. P. 4¾ in. H. P. by 8 in. stroke, having a capacity of 83 cu. ft. of free air per minute to 200 lb. pressure. The generators supply electric energy for charging the storage batteries for engine ignition and for operating the water supply pumps, lighting the power houses and dwellings. The compressed air is delivered to three horizontal air receivers 3 by 15 ft. each, in which compressed air is stored for starting the main and auxiliary engines. The storage battery outfit for ignition includes forty 7-plate cells. The main engines use a mechanical make-and-break ignition, taking current from a spark coil 40 volts and 5 amperes. The gas mixture consists of 12 parts of air to 1 of gas and may be adjusted to suit any variation in the calorific value of the natural gas.

The cooling water for jackets, intercooling between the high and low pressure compressors and also for after-cooling between the high pressure compressor and the gas main to Los Angeles is provided from two reinforced concrete cooling ponds equipped with spray nozzles through which the water is forced by centrifugal pumps.

The pump house contains two 40 h.p., 115 volt, 2000 r.p.m., d.c. motors, are direct connected to two 6 in. volute pumps, which supply cylinder jacket water. The water from the jackets flow by gravity to the cooling pond and is pumped to a 60,000 gal. wood tank, the total working head being 105 ft. There are also five 6 in. volute pumps direct driven by

10 h.p. Sprague d.c. 115 volt motors. These pumps operate the water sprays in the cooling ponds. The building is 25 ft. 4 in. by 46 ft., and like the other has steel frame and galvanized corrugated iron sides and roof.

Water is obtained from two wells, one 730 ft. deep and producing about 175 bbl. per hour, the other 360 ft. deep and producing 150 bbl. per hour. Natural gas under ordinary well pressure is taken from the mains and used for pumping by the Pohli air-lift system, by which the water from the well is discharged into the separating chamber, where the gas and water are separated. The gas goes from there into the 8 oz.

Interior of Taft Pump House.

fuel line to the engines and the water discharges by gravity into treating tanks from which it passes to the cooling ponds.

The arrangement of gas piping to and from the compressor house provides for every reasonable operating contingency. By a system of by-passes the natural gas, after leaving the Taft terminal, may be led to any or all engines or may be cut out altogether and discharged direct into the main to Los Angeles and pass by the compressor station altogether. Practically all inlet and outlet mains are in duplicate, so that an accident to one simply means switching to the other so that service may not be interrupted.

Due to the cooling process, some of the hydrocarbon constituents of the low pressure casing-head gas are condensed into gasoline, which is separated and collected by means of a suitable drip and put into storage tanks. The product runs about 60 degrees Baume and is yellow to dark brown in color. It must be distilled for commercial purposes. The quantity varies from 500 to 1000 gal. per day, depending on the amount of gas handled by the station and the atmospheric temperature. The more gas and the cooler the temperature the more production will be realized.

Throughout the field gathering system, at the Taft terminal at the compressor station, and along the Midway main line, suitable drips or separators have been provided to remove dust, sand, liquid, either salt water, oil or condensation or any foreign matter that may be in the gas.

[To be concluded.]

IRRIGATION PUMPING.

BY G. E. P. SMITH.

(This article contains many practical suggestions of interest to central stations and engineers interested in pumping for irrigation. It is abstracted from a paper on "The Utilization by Pumping for Irrigation of Underground Sources of Water Supply," presented before the International Engineering Congress. The author is irrigation engineer with the University of Arizona in Tucson.—The Editor.)

Pumping for irrigation in a crude form is of great antiquity. In Egypt, India and China old pumps, such as endless chain buckets and scoop wheels, were employed; and the Kairez or long tunnels of central Asia, many of which are still in use, were remarkable examples of groundwater development suited to earlier times. But probably at no time in the past has there been any utilization of groundwaters at all comparable in extent or in effectiveness with that of today in the great Southwest, from Arkansas to California. And, with the advancement in knowledge, in methods, and in machinery, pump irrigation has come to occupy a distinct and important field of engineering activity.

The magnitude of pump irrigation was revealed by the census of 1910. The statistics relating to irrigation show a total of 307,496 acres irrigated by pumping from wells in 1909 in the United States west of the 100th meridian. Ninety per cent of this acreage was in California, and the remaining ten per cent was situated in Arizona, New Mexico, Texas and Washington. Also, the census furnishes data on the irrigation wells in use in 1910. The total number of pumped wells was 14,558, of which 10,724 were in California. The total capacity of the pumped wells was 5,426,139 gallons (20,540 cu. m.) per minute, of which amount 76 per cent was in California, while Arizona, New Mexico and Texas were of next importance in the order named. The census of 1900 did not include any data on wells or irrigation pumping.

Since 1910 there has been a rapid increase in irrigation pumping. Representatives of the office of Irrigation Investigations, U. S. Department of Agriculture, have made a canvass to ascertain the number of new pumping plants installed in California during the years 1911-1914 inclusive. Their estimate is 15,262, which is 164 per cent of the number in use in 1910. Allowing for a moderate number of replacements, it is certain that the number of plants has more than doubled in four years. In Arizona, the percentage of increase is much higher. It is believed that there are four times as many pumping plants in operation now as in 1910. The preparation and cropping of land has lagged somewhat behind the water development, however, and the acreage irrigated at the present time in Arizona is probably not over one-half of the acreage to which the pumping plants are ready to supply water.

From the nature of pump irrigation it is of necessity divided into small projects. Many times, indeed, the projects seem quite insignificant, perhaps a pump capacity of 300 gallons (1.14 cu. m.) per minute and 40 acres of ground. It is only when the hundreds of projects are considered in the aggregate that their importance is truly appreciated. But, it must be remembered that unless the small individual project is scientifically designed and intelligently operated, failure

or a low degree of success will result. Pump irrigation stands or falls with the farmer's individual pumping plant.

Occasionally large groups of pumping plants are designed as a single unit by one engineer. Such are the Portales Valley project in New Mexico, the Tucson Farms Company project at Tucson, Arizona, and the Sacaton pumping project of the U. S. Indian Service. The first named included 69 pumping plants at the outset, the Tucson project has 78 pumping plants, while the Sacaton string of ten wells has a capacity of serving 10,000 acres of land in one unit.

There are many large irrigation pumping projects in central California, Oregon and Washington, which derive their water supply from flowing rivers. These projects are noteworthy on account of the high character of pumping machinery used. Yet they do not depend upon ground water supplies and hence they are outside the province of this paper.

In general the individual plants are operated independently of each other. For various reasons, co-operative pumping is disliked and evaded, but, as will appear later on, there are obvious advantages in co-operation, even for small plants.

The amount of groundwater that can be developed at one place is extremely variable. The geologic criteria for good wells are: clean coarse gravels, and ample continuous supply of water. The former factor is dependent on the character of rocks in the mountains of the watershed. Granite rocks invariably produce coarse sands and gravels, while soft, close-textured rhyolites produce thick beds of clay. The contrast is seen frequently on the opposite sides of a valley. Examples of heavy yields from wells are quite common. The battery of ten wells of the Tempe Canal Company, at Tempe, Arizona, yields 27 second-feet with 14 ft. draw-down. These wells are spaced at 50 ft. intervals and are 200 ft. in depth. The average yield of eighteen 16-in. wells near Mesa, Arizona, drilled by the U. S. Reclamation Service, is 0.32 second-foot per foot of draw-down. The Azusa Irrigating Company, in the San Gabriel Valley, California, has a 26-in. well, 400 ft. deep, which is said to deliver 9 second-feet. The lift at this well is 160 ft. The Covina Irrigating Company has a 26-in. well, of the same depth, which delivers 7.2 second-feet.

The quality of irrigating water is a matter of critical interest to engineers, and not a few wells have been abandoned because the salty character of the water unfits it for irrigation. A costly well near Sentinel, Arizona, was found to contain 575 parts of sodium chloride per 100,000. It was pumped continuously for several weeks at the rate of about 1100 gallons (4164 litres) a minute in the hope of exhausting the brine and obtaining better water, but there was no material improvement. In some localities the first water-bearing stratum yields very alkaline water and the deeper strata yield good water; in other places these conditions are just reversed. Specifications for some recent wells have required separate samples of the water from each stratum for the purpose of analysis. Black alkaline waters can be improved by treatment with gypsum. In the Rillito and Whitewater valleys of southern Arizona the well waters contain sodium bicarbonate, and in both valleys there are beds of crude gypsum close at hand. Water treatment plants for irrigation water supplies are an attractive possibility.

Pumping Machinery.

Economically, pump irrigation is dependent in large measure upon the machinery used. Although this fact has been realized, yet there has been a lack of appreciation of the benefit to be derived from engineering design and supervision of the individual pumping plant. Usually the buyer is a farmer with little or no familiarity with pumping machinery, and he could well afford to expend 5 per cent of the cost of his plant for engineering advice. Ordinarily, however, plants costing less than $10,000 are designed by salesmen, and salesmen, of course, have other interests to serve besides that of the prospective purchaser. The author has seen many instances of stranded farmers whose sad failures were due to the unwise selection of pumps or engines. One man of this class remarked recently, "I bought talk." Herein is a promising field of usefulness for engineers. In every pump irrigation district there should be consulting engineers prepared to write specifications and contracts and to supervise the purchase and installation of pumping machinery, and also to have similar charge of the development of wells. At the present time, contracts are drawn in optimistic vein by the salesmen and the liberal efficiency guarantees are so worded that the farmer cannot check them up.

In the design of farm pumping plants, it should be recognized as a principle that reliability and simplicity are of equal, if not greater, importance than efficiency and fuel economy. A power plant on a farm is at a disadvantage, often it is from ten to fifty miles from a machine shop where lathe work can be done, and the farmer himself is not a mechanic. Plants of less than 30 horsepower should operate without attendance for several hours at a time, and a breakdown at a critical time, when the crops need water, is likely to prove fatal financially.

Pumps.

The pump that is pre-eminently adapted to irrigation uses is the centrifugal pump. Probably 80 per cent of the irrigation water lifted from wells is delivered by centrifugal pumps. The advancement in recent years in the design of pumps of this class has been most gratifying. So late as 1905 very little interest was taken in the scientific treatment of centrifugal pumps; little was known regarding their characteristics, except possibly in three or four factories, where even their meagre knowledge was guarded jealousy. But, in the intervening ten years the design of these pumps has advanced from the "whittling" stage to a scientific basis, and pumps are now available, which in construction and in efficiency, are on a plane with hydraulic turbines.

The plain centrifugal pump with open volute continues to be used much more than pumps with fixed vanes. Plain pumps of high efficiency can be built at low cost, and they are the least of the irrigators' troubles. The proportion of vertical-shaft pumps is increasing, owing to the greater depths at which

ground-waters are being developed; yet where conditions admit of its use, the horizontal pump is rightly preferred. Improvements have been made in the adaptation of impellers to the conditions of head and discharge, in the methods of balance, in the lubrication, in the reduction of clearance, and in the accessibility to the impeller. Greater backward curvature of the impeller vanes and increase of speed give flatter efficiency and input characteristics. The old open-impeller has practically disappeared. A few of the primitive style of pumps are still on the market, but with the growing appreciation of good machinery, they are being driven out.

Vertical-shaft pumps operate best on heads of from 30 to 50 ft. per stage. The practice of using a single stage on lifts from 90 to 110 ft. was tried extensively in 1913 and 1914, but it was found to be impracticable to run the long shafts at the high speed required. Horizontal pumps, on the other hand, can be accurately aligned, and recently-designed pumps speeded at 1800 to 2000 r.p.m. appear to operate successfully.

Vertical turbine pumps designed to go into cased wells have come into wide use. Their problem has been that of the vertical shaft bearings. Separate bearings at the joints of the discharge pipe, protected in various ways from sand and grit, have not proven successful, for enough sand could find its way into the bearings to cut them out rather quickly. But the vertical shaft fully enclosed in a line of oil tubing is long-lived and free from troubles. No longer is it deemed necessary to support the oil tubing from the discharge pipe, but the tubing is put under considerable tension in order to give it supporting power. Until recently these pumps have been built with ball or roller thrust bearings in the pump head, but they can now be obtained with hydraulic balance, a feature of design which is distinctively Californian. The latest improvement is the use of a seal just above the pump bowl, so that the well casing can be used for the discharge column.

During the early years of development of the vertical turbine pump, scant attention was given to the impellers, and the efficiencies shown in tests were uniformly low. During the last year or two, however, great advancement has been made. In a test of a new 5-stage turbine pump, with 14-in. bowl, at the University of Arizona, in May of this year, a maximum combined efficiency of 58.2 per cent was obtained for pump and motor belt-connected, the test being based on the static lift. The maximum efficiency was given with a discharge of 340 gallons per minute and a lift of 26 ft. per stage of pump. Chas. H. Lee, Asso. M. AM. Soc. C. E., has reported on tests made at Los Angeles on a 4-stage 14-in. pump. He found the pump efficiency in excess of 70 per cent for a range of discharge from 450 to 750 gallons per minute. So it is established that good performance is possible from medium-sized turbine pumps.

Vertical turbine pumps are more costly than pit pumps and are not likely to displace them on lifts of less than 100 ft., except in cases where a heavy draw-down is required. The field for the pitless turbine seems to be on lifts from 75 to 250 ft. For developing new wells, the pitless turbine has no equal.

The propeller type of pump which has short helical vanes attached at intervals of about 5 ft. (1.5 m.) along the shaft has been purchased considerably by farmers, and at least a few engineers have been attracted to it. With this type, too, the designers' efforts have been concentrated upon finding shaft bearings which would exclude the grit usually found in well water. Felt packing has been tried, as well as dead-water tubes and caps, and impellers enclosed in short slotted tubes, through which slots water is forced to form a cushion or lubricant between the tube and the discharge column. Bronze, composition metal and lignum vitae have been tried for bearing surfaces. At present, straight guide-vanes are used, either above or below the runners. No authentic tests of these pumps have been reported; but from the fact that large engines are required to operate them, it is believed that their efficiency is low. The problem of the bearings may be solved in time, and it is likely that attention will be given to the curvature of the impeller blades and of the fixed guides, in order to increase the efficiency of the pump. Propeller pumps have an advantage in obtaining a large discharge from well casings of 10-in. size or smaller. A peculiar feature, too, is that the speed required is not dependent upon the lift.

The reciprocating type of pump continues to find a field in irrigation pumping. The conditions, however, requiring a large discharge from a pump set deep below the surface have necessitated the development of entirely new designs. Double-acting pumps with one rod enclosed within the other and pump heads with heart-shaped cams or gears or walking-beam motion effect an overlapping of the power strokes which quite eliminates any pulsations in discharge or in power. And the triple-acting pumps recently introduced, the Glendora pump and the triple-cam Luitwieler, give continuous operation that is practically perfect. Notwithstanding their high cost, the double-acting pumps are much in favor in the foothill regions of Southern California, where the lifts vary from 100 to 400 ft. For the higher lifts, they are used exclusively.

Mention should be made of other types occasionally met with. The bucket elevator is still used to a small extent, as is air-lift also. It is generally recognized, however, that the air-lift is not an irrigation pump, and their number is decreasing. Freak pumps appear frequently, but after a few installations they are seen no more. The first installation in this country of the Humphrey direct-explosion pump, an English type, is being made at Del Rio, Texas, to lift water from the Rio Grande, but this type is not suitable for pumping from wells.

An approximate estimate of the pumping practice in Southern California, based on the quantity of water pumped, is as follows:

	Per Cent.
Reciprocating pumps	20
Horizontal centrifugal pumps	30
Vertical centrifugal pumps in pits	30
Vertical turbine pumps	15
Other types	5
Total	100

In Arizona and New Mexico the percentage of reciprocating pumps is much less, while that of vertical turbines is more than 15.

BALANCING LOAD ON THREE-WIRE THREE-PHASE CIRCUIT.

BY L. T. MERWIN.

With three-phase, three-wire feeders for lighting distribution without automatically controlled regulators for the individual phases, it becomes necessary to keep the load balance on the three phases rather close in order to get anything like satisfactory results as to voltage regulation. Current readings on the three legs at the center of distribution must be frequently taken and the individual single-phase transformers swung from phase to phase to maintain balanced load of the occasional new loads added to the proper transformers already hung. At any rate, the load balance must be approximately maintained, and the writer has found that the following graphic solution, although only approximately correct for inductive loads, is sufficiently accurate for lighting feeders to give very satisfactory results.

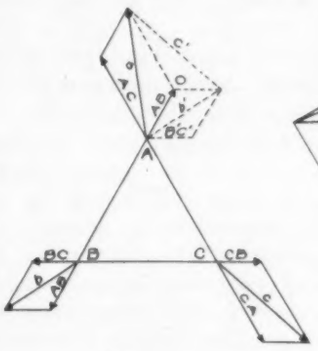


Fig. 1.

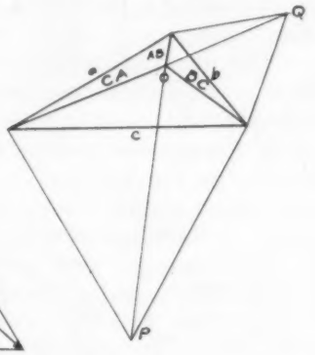


Fig. 2.

Referring to Fig. 1, let **A B C** represent the voltage triangle at the center of distribution, assumed to be equilateral. At **A** let **AC** and **AB** be the phase currents and by the usual vector addition **a** would be the current in leg **A** of the three-phase system. Similarly **b** and **c** are constructed at **B** and **C** respectively. Now superimpose the parallelogram of **B** at **A** as shown by the dotted lines and draw **b′** and **c′**. It is evident that the triangle formed by **a, b′ and c′** is a closed triangle with sides equal to the three line currents, and the lines drawn from **O** to the vertices of this triangle are equal to the three currents in phase with the three voltages of the system, and are therefore proportional to the loads on the three phases respectively, and furthermore, they are 120 degrees apart.

The actual problem therefore reduces itself to forming a closed triangle of the three line currents as measured and drawing from some point within that triangle lines to the vertices and displaced 120 degrees from one another. These lines are then proportional to the actual phase loads.

The geometrical construction is shown in Fig 2. Let **a, b, c** be the sides of the closed triangle formed by taking the three line currents to any convenient scale. On two sides of this triangle, say on **b** and **c**, construct equilateral triangles and from the external vertices of these triangles at **P** and **Q**, draw lines to the opposite vertices of the triangle **abc.** These two lines will intersect say at **O**. From **O** draw a line to the remaining vertex of triangle **abc,** and the three lines from **O** as **AB, BC** and **CA** will be 120 degrees displaced from one another and proportional to the three currents in their respective phases. The multiplication of these currents (using the same scale as for **a, b** and **c**) by the line voltage will give the loads on the individual phases. These being determined the feeder may then be balanced.

The proof of Fig. 2 I leave to the geometrical instinct of the reader. It is a pretty little problem in plane geometry. This is but a particular case of a more general solution where the phase load currents are displaced from one another in accordance with the true voltage triangle—usually a scalene triangle and not equilateral—but the method outlined above is sufficiently accurate for practical work since the feeder end voltages are but slightly distorted for a large load unbalance.

The radio's value in saving lives during the fiscal year 1915, was demonstrated in the case of 26 vessels leaving American ports which met with accident or disaster, requiring the use of wireless to summon assistance. Four of these were from fire; 12 were from running ashore, stranding, or getting into an ice jam; 3 were from the breakage of machinery; 4 resulted from collisions; 1 from shifting of cargo; 1 vessel was storm-battered and water-logged; and 1 was torpedoed. Excepting in the case of the Lusitania, which was torpedoed, the assistance thus rendered resulted in but two lives being lost. Since the close of the fiscal year the disasters occurring have been: On September 13, 1915, the Fabre Line steamship Sant' Anna, bound from New York to Naples with 1700 Italian reservists and crew aboard, caught fire in mid-ocean and all persons on board were saved. The SOS call brought the steamship Ancona to the assistance of the disabled vessel and 600 persons were taken off. The Sant' Anna then proceeded to port, convoyed by the Ancona, and the entire 1700 passengers and crew were saved. Six days after the Sant' Anna disaster the Greek liner Athinai, bound from New York to Piraeus, caught fire in mid-ocean and was abandoned by the passengers and crew, numbering 470. The call for assistance was answered by the steamships Tuscania and Roumanian Prince; 341 persons were taken on board the Tuscania, the remaining 129 being taken off by the Roumanian Prince. The vessel was entirely destroyed. The use of radio apparatus on vessels carrying passengers or with 50 or more in the crew is now accepted as essential to the safety of those on board, and the report of the Athinai shows conclusively that many persons might have been lost and perhaps the cause of the disaster never known had not this vessel been equipped with radio apparatus.

A reactance coil utilizes the counter electromotive force of self-induction to reduce the flow of current in an alternating current circuit. When placed in feeder circuits or in the leads of a generator it is known as a reactor or reactance coil. When used to lower the frequency of oscillation of lightning or other surges it is known as a choke coil.

ELECTRICITY AS A FACTOR IN BUILDING CONSTRUCTION.

BY J. E. VAN HOOSEAR.

(An account is here given of the many varied uses to which electricity may be applied in the construction of buildings. This paper was presented before the Builders' Congress at San Francisco, Oct. 18-23, 1915. The author is assistant engineer of the industrial department of the Pacific Gas & Electric Co.—The Editor.)

A nation, race, or an individual does not stand still, they either advance or fall behind their neighbors. "Know more" has been the means of every advance. We are behind the level which has been reached by our competitors if we do not avail ourselves of the advances made in any line connected with our business, and it is my aim at this time to point out progressive methods on the power end of the construction game.

The service to which electricity can be applied in the construction of buildings, both small and large, and of any material, is increasing and will be found indispensable when the builders fully appreciate the worth of the electric motor driven devices that are now placed at their disposal. It is the aim of the writer at this time to bring out the uses to which electricity is being applied through the motor and otherwise in building construction work, to the profit of anyone connected with the erection of buildings.

Work that can be done by means of electricity is limited only by the desires of the individual, and can be applied from the first operation of clearing a lot to the last operation of polishing the floors.

Starting with the pioneer work of clearing a heavily wooded site that is frequently encountered, a motor driven wood saw is set up to work into cord wood any timber that may be standing on the premises; next, electricity is used to explode powder in removing stumps or rocks from the site; the excavation is accomplished by means of a motor driven excavator which deposits the dirt into trucks that haul it to the dumps and in return deliver the rock, sand and cement that is used in the construction of foundation and walls. In a great number of places where the excavation is deep, large quantities of water accumulates, and it is necessary that this water should be removed in order to proceed with the foundation work; this is easily accomplished by means of a motor driven pump, which needs very little attention, as it can be equipped with an automatic float switch, which will keep the water out night and day. From this stage on, a motor driven saw will be found very serviceable to do all the rough sawing necessary in the construction of the concrete forms and the building frame.

The concrete used for foundation walls, floors and walks is mixed in a motor driven mixer, and hoisted to different levels for distribution by means of a motor driven lift supplied with a special dumping bucket. The bricks and other materials are also hoisted to the several floors by means of electric hoists, thereby saving time and adding to the efficiency.

Some little data have been gathered in connection with concrete work in regard to the quantity of power required in mixing and other work directly connected with it. In a reinforced concrete loft building of three stories, 3000 yards of material were used. A one yard mixer driven by means of a 15 h.p. motor handled the material, a saw driven by a 5 h.p. motor cut all the lumber used in making the forms; these two motors consumed a total of 2000 kilowatt hours, or about 1.5 yards per kilowatt hour. In a steel structure concrete building of eighteen stories, using 1782 yards of material, 829 kilowatt hours of electric current were used, showing a consumption of 1 kilowatt hour for each 2.15 yards mixed. The last named job was done by a contractor who owned several gas engine driven mixers, which he had been using for a number of years. He set one of them up to do this work, and after running a couple of days it developed troubles, causing delay and expense. An electric motor was then secured to complete the work which it did in the usual satisfactory manner. Now, he, like many others who have taken the interest to look into the merits of electric driven machines, will have no other mode of operation.

The plumber has not been left behind, and if the job is large, he will have motor driven pipe and thread cutting machines on it to help him with his work.

If the outside walls are to be plastered, this can be speedily accomplished by means of a motor driven compressed air plastering machine which will lay on a coat of cement plaster to any thickness desired. If the building is of steel structure, the beams can be hoisted and placed by means of an electric driven hoist. In connection with the placing of steel, it has been the opinion of a large majority of those directly interested in this work that the operation can only be accomplished with satisfaction by means of the steam donkey engine; precedent, like a rut in a road, is one of the easiest things to follow, and one of the most difficult to get away from, and I presume is the solution for this. Upon a close study of the matter it is found that the reason for this contention is they either own engine driven hoists, or have tried to do their work with improvised electric driven apparatus which was found unsuited to the task, and being dissatisfied with results, would not listen to anyone regarding the up-to-date motor driven appliances that have speed and control equal to the best of engine driven hoists; it would be well for anyone who is contemplating getting new equipment to investigate the merits of the electric hoist.

After erecting the steel, the rivets that hold it together are driven home and headed by means of hammers operated with compressed air which is supplied by a motor driven compressor.

The plaster which finishes the walls is mixed with motor driven machinery that has been found to give a more thorough mix than was obtained by the old method.

In marble work, motor power is found necessary from start to finish, even to the chiseling and drilling that is necessary in the process of setting it in place.

In fine interior hardwood finish, the electric glue pot is found indispensable and is not a fire hazard.

A unique use has been found for electricity by one of our local builders, in the placing of an electric sign on a large building he was erecting, thereby availing himself of a modern way of advertising night and day the class of building erected, and in an up to date manner.

In the polishing of a great number of large floors of ball rooms, halls, etc., portable scraping and sanding machines have been built, and are operated by motors that form a part of the apparatus. No other mode of drive would serve the purpose, because of the necessity of cleanliness which could not be obtained if coal or gas were used for the purpose of motive power.

What may be of interest to this body is a unique method of mixing and delivering concrete, differing considerably from the old way, and can be used to advantage in cases where very heavy walls are to be built, or in places where the forms cannot be reached from above, and is accomplished by means of compressed air. There are two quite distinct patented ways of doing it. The first requires the usual motor driven mixer, which in turn deposits the mix of about 20 cubic feet into the upper end of a cylinder shaped tank 4 ft. in diameter and 8 ft. long, cone shaped at the lower end and connected with an 8 in. pipe line that delivers the charge to the forms that may be located a considerable distance away, in some cases as far as 2000 ft. The charge is driven from the receiver by means of compressed air under 100 lb. pressure to the sq. in. at a rate of one charge per minute where the distance is around 300 ft., or about three minutes where the distance is 1500 ft., and requires a 200 h.p. motor to drive a 1200 ft. air compressor delivering at 125 lb. pressure per sq. in. The other method uses a smaller tank with 5 in. delivery pipe; the charge of about 10 cu. ft. of sand, rock, cement and water is delivered direct into the tank, no mixing machine being used. The cover is then closed and the compressed air turned into the tank and forces the charge up to the desired location. In passing through the pipe line the material becomes thoroughly mixed. Both of these machines have been used on large tunnel jobs in San Francisco with satisfactory results in cost of delivery of material and quality of work, and there is no reason why they should not be used in building construction as satisfactorily.

There are many other applications of electricity that could be mentioned, as there are special appliances driven by means of electricity for any piece of work that has to be done in the construction of a building, and it is the policy of the central station companies to aid any party who is looking for information along this line with the object in view of further assisting their consumers in the use of their product.

The cost of electrical cooking has been analyzed by the Ontario Hydroelectric Power Commission for an average family during a six months' period in the following table, which excludes energy used for lighting:

No. of persons in family.	No. of families averaged.	Kw.-hr. total.	Cost total	Kw.-hr. per person per month.	Cost per person per month.
2	6	2386	$40.00	40.5	67.8
3	12	2727	63.55	16.0	37.2
4	9	3669	56.89	17.6	27.3
5	6	4705	71.65	27.7	42.1
6	5	4430	77.30	22.4	39.1
7	4	2606	45.15	13.3	23.1
4.3		20,523	$354.54	20.5	35.4

LETTERS TO THE EDITOR.

Confusing the Water Power Issue.

Sir:—In the issue of your Journal of October 2d, there appeared an editorial, "Confusing the Water Power Issue." In this editorial you assume that the Secretary of the Interior, and the Interior Department, are willing to make concessions in the matter of the legislation affecting the hydroelectric uses of the public lands.

I have been in touch with this situation from its inception to this date, and I know that the concessions of the Department are and always have been only in the direction of making certain apparent concessions, all of which they insist upon leaving to the "discretion of the department."

Our experience has taught us beyond question or cavil that these matters, left to the discretion of the Department, are never carried out except where they redound to the further control or authority of the Department. In fact, they are not concessions at all.

The matter was brought up in the Portland conference simply to confuse and mislead, and there were many purely random suggestions from the other side that we ought to be prepared to compromise.

As a matter of fact, if what we are considering is the right and opportunity of development and the ability to finance the developments as the rights of the several public land states, there is no middle ground in this matter.

If, after carrying out the policy for all of our past history, the federal government wants to exact compensation for its proprietary interest in the public lands, we suppose the states and the people of the states and the developing corporations will have to meet this, and if it was legitimately and properly carried out, we would have no fundamental objections to it or other objection, except that, coming at this late date, it is an unfair change of policy.

The United States government has all of the powers of government granted to it under the constitution in these states and over these industries, and that ought to be sufficient. The states have the same powers over the industries within the states, whether on the public lands or not, and that ought to be sufficient.

It therefore follows that the industries of the public lands cannot be successfully or beneficially developed until these fundamental principles of equality and right are recognized, and until the Department is prepared to recognize them there can be no compromise, temporary or otherwise, that will be either beneficial or right.

Yours very truly,

FRANK H. SHORT.

Fresno, Cal., October 23, 1915.

Electric purification of water is accomplished either by the production of ozone to oxidize organic impurities or of ultra-violet rays which destroy any germs which may be present. Both of these methods have received their greatest development in France, where low priced household apparatus is in extensive use.

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Segregating Electrical Contracts

Following the example set by electrical contractors in New York, Pennsylvania, Illinois and New Jersey, electrical contractors in the West should put forth every effort to have laws passed segregating the electrical contract from the general contract in public buildings. Much work has already been done in educating architects and owners as to the advantage of such a separation in private work and the same arguments apply for public work.

There is no logical reason why electrical work should not be let directly to the electrical contractor instead of being sublet through the general contractor. The general contractor is an unnecessary middle man who knows little about the electrical work, who does not finance the job and yet who takes the profit, if any, which legitimately belongs to the electrical contractor.

Furthermore, there is no better means for eliminating the evil of peddling bids, a practice which helps neither the owner, the architect, nor the electrical contractor. The owner does not get the facilities which he expected, the architect has less control of the work and less certainty of competent workmen, and the contractor has less work to do. The central station, also, gets a smaller revenue and many devices are not installed which might otherwise be brought if adequate baseboard receptacles were provided.

The pernicious effect is thus felt by the entire industry, especially as the general contractors' custom of delaying payments injures the contractor's credit. Consequently, every branch of the industry should be interested in educating the architects and the owners as to the advantages of having the electrical work separated from the general contract. This campaign of education might well be conducted in conjunction with the plan to introduce standard specifications which is now engaging the attention of Western men.

The Power of Imagination

Imagination has so frequently been associated with hallucination that the man of imagination is usually condemned as an idle dreamer and classed with the lunatic, the poet, the promoter and others who make dreams their main object in life. Imagination has been in bad company so long that it also has acquired a bad name. Thus do word-meanings, like children, depart from the ways of their upbringing.

There is need for more of this picturing power of the mind in business and science. Like all things else its good depends upon the manner of its use. Without imagination there would be no action. The imagination, and likewise the action, must needs be controlled. Like the waterfall it should be harnessed and set to work. An uncontrolled imagination represents wasting mentality, just as unused water power is wasted energy, irrevocably lost. Progress comes from applied imagination. All advance and success is dependent upon this creative, penetrative power of

the mind. Imagination is the key to opportunity and the main spring of hope.

The salesman's first aid in arousing interest is his imagination, his ability to describe and explain his proposition so as to form an attractive mental picture in the mind of the buyer. Imagination is the chief component of enthusiasm, so essential to success in selling. It is also the basis of service, thinking of ways to help other people.

The executive needs imagination to inspire ideals and arouse enthusiasm in his organization. Executive ability depends upon the power of getting work out of people. An executive's power of getting his men to work turns on his power of supplying them with ideals. He should make the spirit of achievement take the place of the spirit of weariness. He should teach the joy and satisfaction which comes from work well done, instead of allowing his people to think of ways of getting out of things. To devise a game for his organization to play, to enthuse and to spur to action, he should have imagination. A man of broad vision is never visionary. As Thomas Carlyle once said "The degree of vision that dwells in a man is the correct measure of men."

The man of science is prone to treat imagination with disdain. Yet many of the fundamental principles which guide him in his work were the products of deductive reasoning. Copernicus' heliocentric theory of the solar system, Darwin's theory of evolution and Newton's law of gravitation were formulated by dreamers. The conception of the ether and the electron would have been impossible without the deductive method which so many scientists decry. It is the scientist with imagination who enunciates the truth for the experimenter to prove. Be it not thought, however, that imagination can ever supersede experiment. But without the exercise of imaginative generalization many natural laws would still be unknown quantities. Mere facts are barren without minds capable of choosing between them, minds which under the bare fact see the soul of the fact, its relation to other facts. It is the unexpected assemblage of diversities into unity which makes for scientific progress. This is the function which can be fulfilled only by imagination.

Natural Gas at Los Angeles

The efficient utilization of natural gas, next to the utilization of water power, represents the highest type of conservation. Were it not for its ephemeral character natural gas would be numbered among the most valuable of those resources with which nature has endowed us.

Even with this handicap, the natural gas industry has taken its place in big business in the United States, the country to which the credit is due for its commercial application. Close to six hundred billion cubic feet of natural gas were consumed during 1914, the value being nearly one hundred million dollars.

While the California consumption represents only about three per cent of the total, both as to quantity and value, the state has already assumed sixth place in the list and with the operation of the systems which recently started to supply Los Angeles, will probably assume third place this year.

The manner in which one of the most important sources of supply in California was developed so as to serve Los Angeles and vicinity is interestingly told in the leading article of this issue. Particular interest attaches to the provisions which have been made to care for the probable temporary nature of this supply and also to the length of the line, the main wells being more than one hundred miles distant from the point at which the gas is distributed for consumption.

The first results of the introduction of this cheap and convenient fuel into the Los Angeles market has been to somewhat disturb existing conditions. During the next few years much less artificial gas will be manufactured in Southern California. The natural gas sells for about half the price charged for the artificial, and has a heat content of 1000 B.t.u. as compared to the 600 B.t.u. standard prescribed for the latter. This makes it an ideal fuel for heating homes and for industrial purposes. The existing systems are used to distribute either the natural gas or a mixture of the natural and artificial product. With the ultimate exhaustion of the supply the pipes will again be available for their original purpose. So aside from a temporary disarrangement of the plans of the existing utilities, the effect will be most beneficial in giving industrial advantages to the communities served.

Another interesting side light on the local situation is the proposal of the City of Los Angeles to go into the business of distributing natural gas. Judging from the time that has elapsed in the consumation of plans to distribute aqueduct electric power, there is some likelihood that a municipal gas system, if adopted, would be ready for use about the time that the gas supply is exhausted.

Be this as it may, the criminal waste of natural gas is fast becoming a thing of the past in California, as elsewhere. Transmission lines are being extended each year to new communities and more efficient means are rapidly being devised for burning the gas.

Another means of utilization and an additional source of revenue is the extraction of gasoline from "casing-head" gas by means of compressors. With the discovery that this compressed product can be mixed with a heavier gasoline and the blend redistilled to give a product with no greater explosive liability than that carried by the ordinary gasoline, an ever-increasing market is offered by the automobile.

The completion of this gas line marks an important period in the conservation of natural resources in the West. It also bears out the principle that true conservation consists in wise utilization. As a result of the introduction of this cheap and satisfactory fuel Los Angeles seems destined to become even a greater manufacturing center.

PERSONALS

W. R. Hendrey, manufacturers' agent of Seattle, is at San Francisco.

W. C. Wurfel, Pacific Coast manager of the Westinghouse Lamp Company, is at Portland.

H. P. Munger of the Hughes Electric Heating Company, Chicago, Ill., is at San Francisco.

W. S. Berry, sales manager Western Electric Company, San Francisco is at Los Angeles.

I. Cantorovitch, electrical dealer of Shanghai, China, was a recent arrival at San Francisco.

W. M. Deming of the General Electric Company, Schenectady, New York, is at San Francisco.

A. J. Myers, representative of the Wagner Electric Company, San Francisco, is at Los Angeles.

W. B. Palmer, an electrical dealer of Los Angeles, was a visitor at San Francisco the past week.

J. H. Carr of the Valley Electric Supply Company, Fresno, recently spent a few days at San Francisco.

A. W. Leonard, president of the Puget Sound Traction, Light & Power Company, is at San Francisco.

J. C. Broili, president of the Nevada Machinery & Electric Company, Reno, Nev., is at San Francisco.

F. O. Broili, industrial engineer of the Northwestern Electric Company, Portland, Ore., is at San Francisco.

P. M. Downing, chief engineer of the Pacific Gas & Electric Company, San Francisco, is on a trip East.

N. D. Powell, electrical contractor of Stockton, Cal., spent a few days at San Francisco during the past week.

C. V. Schneider, electrical contractor of Sacramento, spent a few days during the week at San Francisco.

C. W. Booth, electrical engineer Pacific Lumber Company, Scotia, Cal., spent a few days recently at San Francisco.

H. D. Havery, representative of the Electric Appliance Company for Arizona, was a recent visitor at San Francisco.

H. L. Jackman, manager Western States Gas & Electric Company, Eureka, Cal., was a recent visitor at San Francisco.

Thomas Finigan, vice-president of Pierson, Roeding & Company, San Francisco, is on a business trip throughout the East.

Steul Gamble, division manager of the Great Western Power Company at Petaluma, spent the week at San Francisco.

O. B. Stubbs, proprietor of the Stubbs Electric Company, Portland, Ore., has returned from a two weeks' visit at San Francisco.

T. Dillon, division superintendent of the Great Western Power Company at Sacramento, was a recent visitor to San Francisco.

Senor Jose M. de Lesarte, professor of engineering of the Industrial School of Barcelona, Spain, was a recent visitor at San Francisco.

J. Harnett, of the Western States Gas & Electric Company, Humboldt, Cal., spent a few days during the week at San Francisco.

A. H. Noyes, Northern California representative of the Electric Appliance Company, spent a few days during the week at San Francisco.

Thomas E. Collins, Tribune of the Jovian Order, has been advanced to the position of Chief Stentor by the recent Jovian Congress held in Chicago.

F. E. Auber, an electrical contractor of Ukiah, has succeeded **W. Bromley** as superintendent of the municipal light plant, **Mr. Bromley** having resigned to engage in the banking business.

C. F. Carroll, representative of the Standard Electric Stove Company, is visiting the Pacific Coast. The Pacific Coast Specialties Company of Oakland have been made California agents.

F. S. Baldwin, general sales manager for Pass & Seymour, Inc., Solway, N. Y., accompanied by **W. Brewster Hall,** the company's Pacific Coast representative, are visiting Portland and Seattle.

Chas. A. Rolfe, president of the Southwestern Home Telephone Company of Redlands, Cal., was in San Francisco this week, being in attendance at the meeting of the Independent Telephone Association of America.

G. N. Lemmon, consulting engineer railway and industrial engineering department Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., who is making a trip of the Pacific Coast, was a recent arrival at San Francisco.

Robert L. Eltringham, electrical engineer for the Industrial Accident Commission of California, is on a trip to Washington, D. C., to attend a conference of the Bureau of Standards with the engineers of the various central stations of the United States.

MEETING NOTICES.

Oregon Society Engineers.

The regular monthly meeting of the Oregon Society of Engineers was held at the Portland Commercial Club, Friday evening, October 22d. The society entertained their friends with an exhibition of the Berger-Jones color pictures of the Columbia River Highway, Crater Lake and snow-capped mountains of Oregon. The pictures were shown by stereopticon machine. Mr. Henry Berger, Jr., gave a short talk on the art of color photography.

San Francisco Section A. I. E. E.

In view of the large number of meetings and conventions which have been held at San Francisco during the past year it has been decided that there will be no technical meetings of the local section of the American Institute of Electrical Engineers during the balance of the year. The executive committee has decided to call a general get-together meeting and smoker about the first of December in order to stimulate interest and promote good-fellowship.

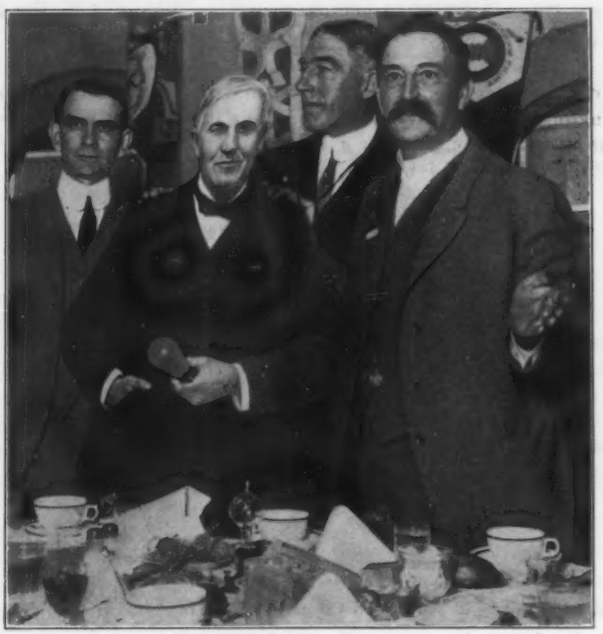
Electrical Development and Jovian League.

October 20th was the league's Edison Day meeting, and some seven hundred electrical and business men sat down at luncheon in recognition of the guest of honor, Thos. A. Edison, many being obliged to forego the pleasure owing to lack of accommodations. The chairman of the day was Mr. John A. Britton, vice-president of the Pacific Gas & Electric Company, who introduced Mr. Samuel Insull as speaker, after paying the genius of Mr. Edison a glowing tribute. Among the guests at the speaker's table was H. Ford, Wm. Bee, Mr. Edison's secretary; Geo. Holberton, president of the league; Dr. Thos. Addison and Frank Fagan, in whose hands was placed the arrangement of the programme, and who accompanied the party as guest on the Southern California trip. Mr. Edison left Tuesday evening, October 26, for Los Angeles, where he will be met on arrival by the Chamber of Commerce and J. A. Lighthipe.

The Jovian Eletcrical League of Southern California.

Edison Day was most fittingly celebrated by the Los Angeles Jovians and their friends, 300 of whom crowded the banquet rooms of Christopher's on October 21, and enthusiastically cheered the wizard, who was present in splendid fac simile. Tribune Holland, in a few well-chosen words, introduced J. A. Lighthipe, an old associate of Mr. Edison, who, with his hands on the shoulders of the inventor, introduced him to the audience, who cheered him to the echo. Each guest was the recipient of a replica of Mr. Edison's first lamp, mounted on a wooden base, and suitable for burning on a 110-volt circuit, and also a paperweight, made of a piece of the Big Creek aluminum cable, the gift of the

Pacific Light & Power Corporation, who were represented by forty-five of its employees, headed by Vice-President E. R. Davis. During the introduction of guests, Mr. Ballard presented Mr. Hoxey, of New York, as professor in the college of severance charges, teaching the lesson that cities must not endeavor to obtain public utilities without due compensation. Among others present were several mayors of near-by cities. Cheers greeted the announcement that Dick Northmore of the Los Angeles Gas & Electric Company, had that day received the honor of being elected to the 33rd degree of Masonry. Mr. Winninger, the husband of Blanche Ring, then rendered a number of splendid humorous musical selections,



J. A. Lighthipe Introducing "Mr. Edison"; Paul Shoup and Tribune Holland in Back.

and, in view of the absence of his wife, received the bouquet which "Old Friend" Holland had intended for the star. The chairman of the day, R. C. Starr, came in for much applause when he arose to introduce the speaker of the day, as did also Harry Sessions, who, as chairman of the program committee, was responsible for the excellent program and the presence of Mr. Edison, a la cardboard, with lamp in hand. A telegram of congratulation was sent to Mr. Edison and a committee was appointed to arrange for a suitable demonstration in his honor when he comes to Los Angeles, consisting of Messrs. Lighthipe, Baurhyte and Davis, one representative from each of the power companies. The diners then listened to an epoch-making address by Paul Shoup, president of the Pacific Electric Railway Company, presenting able and fearless arguments in favor of a square deal for the street railways. This will be published in the next issue of this journal.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

Carl B. Bell and John L. Butler of Colfax, Placer county, have filed with the commission an application for permission to sell the Colfax telephone exchange to Mrs. S. K. Morrison of Reno, Nevada. The exchange is valued at $3500, and Mrs. Morrison offers this amount in cash to the owners.

The Modesto Gas, Light, Coal & Coke Company of Modesto, Stanislaus County, has filed with the commission an application for authority to issue $200,000 30 year 6 per cent bonds, to be sold at not less than 90 per cent par, and to be secured by a trust deed to the Union Trust Company of San Francisco. The company desires to sell $65,000 of the issue at once, the remainder to be used at such time as business may require. The applicant says that the company is indebted to Frank A. Cressey for money advanced, in the sum of $46,277.20, and that it owes the Farmers & Merchants Bank of Modesto $3013.05.

The Santa Barbara Gas & Electric Company has filed with the commission an application for authority to sell thirteen of its 6 per cent 30 year bonds to pay for betterments and additions to its plant. The bonds are to be sold for $13,000.

TRADE NOTES.

The Los Angeles branch of the Century Electric Company, St. Louis, Mo., owing to a large increase of their business, has been moved to larger quarters at 806 South Hope street. R. J. Davis is Pacific Coast manager and Paul A. Shilton will be in charge of this branch.

The Holtzer-Cabot Electric Company has recently moved into the new factory and offices in the Roxbury district of Boston, Mass., thus bringing all its departments under one roof. The building is of reinforced concrete construction, fireproof, and contains six floors or an area of 24,000 sq. ft., exclusive of the power plant.

The Ogden, Logan & Idaho Railway Company is going to modernize its train dispatching. An order has been placed with the Western Electric Company for one complete train dispatching system, including 30 way station equipments, dispatcher's outfit and attendant telephone sets and material. The railroad company feels that the new system will solve their dispatching problems and serve to increase their transportation facilities.

During the week of October 4th the Hurley Machine Company conducted a series of window demonstrations of its Thor Washing Machine at the store of the Gas & Electric Appliance Company, San Francisco. This is a part of the great publicity campaign now covering the Pacific Coast for this company. Demonstrations are also being made in various sections of San Francisco being participated in by the General Electric Con. Co., and the Levy Electric Co.

BOOK REVIEWS.

"The Electric Railway." By A. Morris Buck; 390 pp., 6x9 in. Published by McGraw-Hill Book Company, New York City, and for sale by Technical Book Shop, San Francisco. Price, $3.00.

This has been written as a text book for advanced students taking electric railway courses. It consequently deals much with which the practical man would call the obvious. Nevertheless the practicing engineer will find its eighteen chapters of interest and value, particularly as regards speed time curves and motor control. Power requirement and energy consumption, electric locomotives and self-propelled cars, track, the overhead circuit, and signalling systems all receive due and proper attention.

"Test Methods for Steam Power Plants." By E. H. Tenney; 224 pp., 5x7 in.; leather cover. Published by D. Van Nostrand Co., New York, and for sale by Technical Book Shop, San Francisco. Price, $2.50.

In compact form is here presented a manual of methods dealing with the economical and efficient operation of steam power plants. The first two chapters are devoted to the purchase and testing of coal and to the economy of coal combustion. They are consequently of little interest to Western engineers using fuel oil, as is likewise the chapter on evaporative tests for capacity and efficiency. However, the instructions for treating and testing boiler-feed water, prime movers and lubricants more than compensate for the lack of information regarding oil practice. The directions are so plain and the explanations are so simple that any steam engineer should be able to apply them in increasing the efficiency of his plant.

INDUSTRIAL

NEW LUMINOUS REFRACTOR ARC LAMPS AT CHICO.

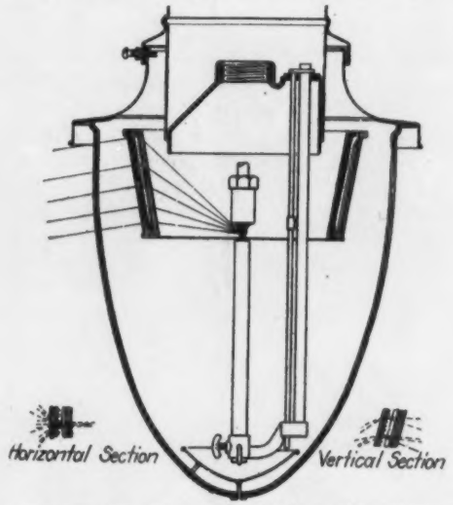
As mentioned in a previous issue of the Journal, a trial of new highway lighting units is being made on the California State Highway between Chico and Red Bluff that promises a revolution in California roadway lighting. The installation represents a new departure on the coast, and has made a very favorable impression with the central station men and State Highway engineers who have seen it.

The lighting units used are the new type General Electric luminous arc lamps, equipped with prismatic refractors and high efficiency electrodes, and were developed especially for roadway lighting. It has been found by long tests that better results in highway lighting are obtained by combining the energy of several smaller candlepower lamps in one large lamp and spacing them farther apart. The result is a silhouette effect on objects in the roadway, due to the large light source behind them, and the wide angle of distributicn of the lamps. Objects can be seen at a much greater distance than would be possible under the low intensity of small candlepower lamps, and small obstacles in the road are easily seen. Another decided advantage of going to high-power lamps is the increase in illumination efficiency; i.e., increased candlepower per watt consumed.

The lamps themselves are the well known magnetite or luminous arc lamps which have been in use in increasing numbers for the past twelve years. The special features of the Chico lamps are the prismatic refractors and high efficiency electrodes, which result in increased illumination and maximum efficiency with a wide angle of distribution. The electrodes are the improved magnetite or iron oxide base electrodes producing a high intensity pearl-white light. The refractor takes the place of the reflector with its similar function of redirecting the upward rays downward onto the road surface. The refractor itself is made of two sections of prisms, one horizontal and one vertical, fitted together with the grooves inside. The inside section of horizontal prisms redirects the upward rays along the 10 deg. angle below horizontal and the other vertical prisms diffuse the redirected rays to eliminate all glare.

The design of the new lamp, with the refractor, is such that the candlepower increases at every angle from the vertical beneath the lamps up to the 10 degree angle below horizontal. This angle has been found to be the critical angle for maximum candlepower beam, as the roadway is then most uniformly illuminated. Light above the 10 degree angle is largely wasted if its effectiveness for roadway illumination only is considered.

The new highway lamp is designed for various candlepowers and wattages, and is an extremely flexible unit for all classes of service. The lamps at Chico are operating at 4 amperes, 310 watts and deliver 1600 candlepower at the 10 degree angle. They are spaced 650 ft. apart, and hang 25 ft. above the highway. The accompanying illustration shows the effective way in which the full surface of the highway is illuminated and the silhouette effect on passing vehicles. Similar results, in a greater degree, are obtained by placing the lamps closer together, as would be done on residential streets of cities, or to a lesser degree if the lamps are spaced further apart on outlying sections of the highways. Their extremely low maintenance cost and high efficiency fit the lamps particularly for these classes of lighting, and the steady, pearl-white light is decidedly pleasing.



Luminous Arc Lamp with Prismatic Refractor, showing Distribution of Light.

Illumination of California State Highway with Luminous Refractor Arc Lamps.

NEWS NOTES

ILLUMINATION.

CALAVERAS, CAL.—An election will be held November 5th for forming a public highway lighting district in the town of Valley Springs.

CHOTEAU, MONT.—A petition is being circulated by residents of Hobson addition asking for the extension of lighting system into that district.

ELKO, NEV.—G. E. Wakefield of the Nevada Gas, Heat & Light Company, was here recently in connection with the company constructing a gas plant in this city.

EUREKA, CAL.—Sealed bids will be received by the city clerk for furnishing the city of Eureka with street lights for one year commencing January 1, 1916.

PHOENIX, ARIZ.—The South Side Gas & Electric Company has applied to the county supervisors for a franchise to extend its light and power lines to the Evans school.

PASADENA, CAL.—The city commissioners have awarded the contract for work in Mentoria Court to the F. O. Engstrum Company, including the installation of ornamental lighting posts.

SANTA ANA, CAL.—The trustees have adopted a resolution ordering street lamps installed on Fourth street from Mortimer to Rose street, and on Main street from Second street to Sixth street.

SEATTLE, WASH.—The city of Seattle has applied for an electric franchise in the southern portion of King county. A hearing will be held January 18, 1916, by the board of county commissioners.

SILVERTON, ORE.—It is expected that an election will be called about November 15th for the city electors to decide whether the city shall bond itself for the purpose of constructing a lighting system.

SPOKANE, WASH.—The city council has adopted a resolution for electrolier curb lighting on the south side of Trent avenue between Division and Lincoln streets. The estimated cost of the improvement is $28,000.

LEBANON, ORE.—Scroggin & Washburn are preparing to rebuild the electric light and power plant, which was destroyed by fire. The builders expect to have the new building up and machinery installed by December 1.

RIVERSIDE, CAL.—The city council has granted the request of P. T. Evans that the High Palm tract on Magnolia avenue be put into the district for the installation of an ornamental street lighting system on Robusta street.

ACME, WASH.—Representatives of the Puget Sound Traction, Light & Power Company have looked over the proposition of a lighting system in Deming, and report favorably. It is probable that the company will extend its wires from Rome.

NEWPORT, CAL.—The trustees have started proceedings for calling an election for voting bonds for the establishment of a distributing system for gas. The amount of the proposed issue is mentioned at $20,000, interest 5 per cent, figures subject to revision.

SPOKANE, WASH.—Electrolier lighting on Trent avenue is assured by a resolution introduced to the city council by Mayor Fassett. Property owners have petitioned for the improvement. The estimated cost for the system and for use of current for ten years is $28,000.

GILROY, CAL.—The only bid received for leasing the local electric light and power system, was that of the Coast Counties Gas & Electric Company, the present lessee. The company asked for a 10 year lease, as the rebuilding of the system throughout the city would be considerable expense. The bid was taken under advisement.

REDDING, CAL.—The city trustees gave a favorable hearing to a proposal by E. A. Rolison to install a new lighting system that will provide for the purchase of current from Northern California Power Company, the city to do its own distributing and to install its own lamps. Rolison has been instructed to prepare plans and estimates of cost.

TRANSMISSION.

MANSFIELD, WASH.—An ordinance has been passed granting a franchise to the Okanogan Power Company to extend its electric lines to Mansfield.

BLACKFOOT, IDAHO.—James Young, engineer, has been employed by the council to inspect sites on Blackfoot river under consideration for location of a municipal electric light and power plant.

GOLDENDALE, WASH.—The commissioners of Klickitat county have ordered that the petition of the Pacific Power & Light Company to construct power lines along the roads of said county be granted.

WASHINGTON, D. C.—Secretary Lane of the Interior Department has issued a permit to J. H. Cline for an hydroelectric plant on Big Creek in Kalispell land district. The project will furnish power to Polson, Mont.

COLVILLE, WASH.—A hydroelectric power plant is planned for erection at Waneta, B. C., at the confluence of the Columbia and Pend Oreille Rivers. A dam will be built across the gorge and 80,000 h.p. will be developed.

OLYMPIA, WASH.—An ordinance has been passed granting to Millard Lemon and Wilbur B. Foshay the right to construct and operate lines for transmitting electrical energy for light and power for public use along the public ways of Olympia.

TACOMA, WASH.—The board of county commissioners has set November 12 as the date of hearing of the proposed franchise for the Puget Sound Traction, Light & Power Company to construct and operate lines for transmitting electric power over the highways of Pierce county.

TRANSPORTATION.

PORTLAND, ORE.—Regular service has been established between Portland and Mount Angel by the Willamette Valley Southern Railway, the running time being two hours.

LOS ANGELES, CAL.—Sealed bids will be received by the Board of Supervisors up to November 22 for the purchase of a franchise to construct and for 40 years to maintain an electric street railroad in Los Angeles county.

LOS ANGELES, CAL.—The city council has instructed the city attorney to prepare notice of sale of the single or double track electric railway as part of the Gardena-San Pedro line, and connection of same with the Dominguez, San Pedro line, and to provide for both passenger and freight traffic.

CLARKSTON, WASH.—The Lewiston-Clarkston Transit Company has filed a petition with the board of commissioners of Asotin county asking for a franchise to pass their tracks from the limits of the city of Clarkston up Sixth street, to Highland avenue, and west on Highland avenue. The matter comes up for consideration November 3.

CLARKSTON, WASH.—The Lewiston, Clarkston Transit Company has applied to the board of county commissioners of Asotin county for a franchise to extend its system of railway tracks along Sixth street in Vineland from the limits of the city of Clarkston to Highland avenue, and from Highland avenue to Thirteenth street.

ALPHABETICAL INDEX TO ADVERTISERS

The letter and number before each name are used in the classified page following

A-1 American Ever-Ready Works of National Carbon Co.... Los Angeles; 755 Folsom Street, San Francisco; Seattle.

Atchison, Topeka & Santa Fe Railway Co..... 673 Market St., San Francisco; 1218 Broadway, Oakland.

B-2 Benjamin Electric Manufacturing Co..... 590 Howard Street, San Francisco

B-5 Bridgeport Brass Co..... 4 (See Pierson, Roeding & Co.)

B-7 Busch-Sulzer Bros.-Diesel Engine Co..... 5 Rialto Bldg., San Francisco.

C-1 Century Electric Co.....12 906 So. Hope Street, Los Angeles; 56 Natoma Street, San Francisco; 65 Front St., Portland, Ore.

C-3 Crocker-Wheeler Co.....12 Salt Lake City; Crossley Bldg., 618 Mission St., San Francisco; Seattle.

C-4 Cutler-Hammer Manufacturing Co..... 579 Howard Street, San Francisco; Morgan Bldg., Portland, Ore.; San Fernando Bldg., Los Angeles.

D-1 D. & W. Fuse Co..... Western Electric Co.

D-4 Davis Slate Manufacturing Co..... Chicago, Ill.

D-2 Dearborn Drug and Chemical Works..... 5 355 East Second Street, Los Angeles; 301 Front Street, San Francisco.

D-3 Dover Manufacturing Co..... Canal Dover, Ohio.

E-1 Edison Lamp Works of General Electric Co..... Rialto Bldg., San Francisco.

E-2 Edison Storage Battery Supply Co..... 5 441 Golden Gate Avenue, San Francisco.

E-3 Electric Agencies Co..... 247 Minna Street, San Francisco; Central Building, Los Angeles.

E-4 Electric Storage Battery Co..... Pacific Electric Bldg., Los Angeles; Spalding Bldg., Portland; 118 New Montgomery Street, San Francisco; Colman Bldg., Seattle.

E-5 Electric, Railway & Manufacturers Supply Co..... 84 Second Street, San Francisco.

F-1 Fairbanks, Morse & Co..... 3 Los Angeles; Portland; 651 Mission Street, San Francisco; Seattle; Spokane.

F-3 Federal Sign System (Electric)..... 4 618 Mission Street, San Francisco.

G-1 General Electric Co.....10 124 W. Fourth Street, Los Angeles; Worcester Bldg., Portland; Rialto Bldg., San Francisco; Colman Bldg., Seattle; Paulsen Bldg., Spokane.

G-2 General Vehicle Co..... 1117 Van Ness Avenue, San Francisco; 331 Wall Street, Los Angeles; British Columbia Electric Ry., Ltd., Vancouver, B. C.

H-1 Habirshaw Wire Co..... (See Western Electric Company.)

H-2 Hemingray Glass Co.....11 330 So. L. A. Street, Los Angeles; 345 Oak Street, Portland; 807 Mission Street, San Francisco.

H-5 Hunt, Mirk & Co..... 141 Second Street, San Francisco.

H-7 Hurley Machine Co..... New York and Chicago.

I-1 Indiana Rubber and Insulated Wire Co..... Fobes Supply Co., Portland and Seattle.

K-1 Kellogg Switchboard and Supply Co..... Aronson Bldg., San Francisco.

K-2 M. W. Kellogg Co..... (See Pierson, Roeding & Co.)

L-1 Leahy Manufacturing Co..... 11 Eighth and Alameda Street, Los Angeles.

L-2 Locke Insulator Manufacturing Co..... 4 (See Pierson, Roeding & Co.)

M-2 McGlauflin Manufacturing Co.....11 Sunnyvale, Cal.

M-4 Morse Chain Co..... Monadnock Bldg., San Francisco.

M-3 Moore & Co., Charles C..... 3 Van Nuys Bldg., Los Angeles; Spalding Bldg., Portland; Kearns Bldg., Salt Lake City; Sheldon Bldg., San Francisco; Mutual Life Bldg., Seattle; Santa Rita Hotel Bldg., Tucson.

N-1 Nason & Co., R. N..... 151 Potrero Avenue, San Francisco.

N-2 National Conduit & Cable Co., The..... Trust and Savings Bldg., Los Angeels; Rialto Bldg., San Francisco.

N-3 National Lamp Works of G. E. Co..... (All Jobbers.)

N-4 New York Insulated Wire Co..... 629 Howard Street, San Francisco.

N-5 Northwestern Pacific Railroad..... 11 808 Phelan Bldg., San Francisco.

O-1 Okonite Co. (The) .....12 (All Jobbers.)

P-1 Pacific Electric Manufacturing Co..... 80 Tehama Street, San Francisco.

P-2 Pacific States Electric Co..... 2 236-240 So. L. A. Street, Los Angeles; 90 Seventh Street, Portland; 200-210 12th Street, Oakland; 575 Mission Street, San Francisco; 307 First Avenue, So., Seattle.

P-4 Pelton Water Wheel Co..... 5 2219 Harrison Street, San Francisco.

P-5 Pierson, Roeding & Co..... 4 Pacific Electric Bldg., Los Angeles; Rialto Bldg., San Francisco; Colman Bldg., Seattle.

P-7 Pittsburgh Piping & Equipment Co.....12 Monadnock Bldg., San Francisco.

S-1 Schaw-Batcher Company, Pipe Works, The..... 211 J Street, Sacramento; 356 Market Street, San Francisco.

S-3 Simplex Electric Heating Co.....12 612 Howard Street, San Francisco.

S-4 Southern Pacific Co..... 3 Flood Bldg., San Francisco.

S-5 Sprague Electric Works..... 3 Rialto Bldg, San Francisco; Colman Bldg.; Seattle; 124 West 4th Street, Los Angeles; Electric Bldg., Portland; Paulsen Bldg., Spokane.

S-6 Standard Underground Cable Co..... First National Bank Bldg., San Francisco; Hibernian Bldg., Los Angeles; Yeon Bldg., Portland; Central Bldg., Seattle, Wash.

T-1 Thomas & Co., R..... (See Western Electric Co.)

W-2 Western Electric Co..... 2 Eighth and Santee Streets, Los Angeles; 1901 Telegraph Avenue, Oakland, Cal.; 680 Folsom Street, San Francisco; 907 First Avenue, Seattle; 45 North Fifth Street, Portland, Ore.

W-4 Westinghouse Electric and Manufacturing Co..... 6 50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; 165 Second Street, San Francisco; Second and Cherry Streets, Seattle; Paulsen Bldg., Spokane.

W-5 Westinghouse Machine Co..... 141 Second Street, San Francisco.

W-6 Westinghouse Lamp Co..... (See Westinghouse Electric and Manufacturing Co.)

W-8 Western Pipe & Steel Co..... 444 Market Street, San Francisco; 1758 North Broadway, Los Angeles.